

Report

Bioinformatics Research and Education in Germany

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Bioinformatics play a key role in the progress of molecular biology and genome research. In fact, the ongoing transition of molecular and cellular biology into an industrial-style, large scale science with significant medical and thus economic impact would be inconceivable without bioinformatics. In many particular questions, existing techniques from mathematics and computer science have not been sufficient to support life science research. Bioinformatics, as a result, is not only bringing existing methods to bear on the new problems but also developing, or catalyzing the development of novel techniques in these formal sciences. With its increased importance, the fostering of bioinformatics has become a crucial part of German efforts to promote biotechnology and the life sciences in general. The difficulties, however, lie in the strongly interdisciplinary nature of the field as well as in getting computational methods accepted by laboratory biologists and medical researchers.

Germany has a remarkably strong tradition in bioinformatics. For example, Germany was the first country worldwide where an annual scientific meeting on bioinformatics started in 1985 (now GCB - "German conference on bioinformatics"). This led to an early formation of a scientific community when in other countries the researchers in this field were highly scattered. The existence at EMBL Heidelberg of the Biocomputing Programme under the leadership of Chris Sander also helped to establish theoretical approaches to molecular biology. Furthermore, a bioinformatics coordination group formed by the several professional societies (GDCh, GMD, Dechema, GI and GMDS) and headed by Dietmar Schomburg developed a concept that led to a funding scheme by the German research and technology ministry in the early nineties. The essential condition for funding was a cooperation between a biological/biochemical group and a computer science/mathematical group. This introduced computer science groups to the field of bioinformatics and led to a remarkable increase of collaboration with subsequent significant progress in the field.

Since the funding scheme enacted by the German government in the early nineties a number of excellent, internationally recognized German groups have developed in the field and are still dominating the present national research situation. Although it is impossible to name all, some names should be mentioned here: Lengauer, formerly Bonn and now Saarbrücken, Schomburg, first Braunschweig, now Köln, Mewes, München, Suhai and Bork, Heidelberg, Vingron, Berlin - to name just a few. Essential and unique German contributions are the Mewes activities in genome data integration and annotation (in

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particular in the yeast and Arabidopsis sequencing projects), the enzyme and metabolic information system BRENDA run by the Schomburg group and the transcription factor database TRANSFAC run by the Wingender group in Braunschweig.

In spite of the strong research record - and similar to the situation worldwide - the universities were slow in teaching students in the field of bioinformatics. Academic and industrial research was hampered by a dramatic lack of bioinformatics researchers. This became especially obvious in the mid-nineties. In order to overcome this critical situation DFG, the basic science funding agency, enacted a five-year funding scheme for universities for bioinformatics teaching. Finally, to preserve the rather strong German position in bioinformatics research and to allow a quick "production" of trained bioinformaticians the German federal ministry of education and research (BMBF) started a funding scheme for six competence centers in bioinformatics.

Several of the centers funded by DFG and BMBF have meanwhile established strong educational programs in bioinformatics. With Bielefeld having had a lead role in teaching for many years, Tübingen, Munich, Saarbrücken, Berlin and several other universities have now established curricula, too. Bioinformatics research, also strongly supported by the funding agencies, has different emphasis in the various centers. Munich, Berlin and Jena are strongholds of genome research. In Munich the group of Hans Werner Mewes has not only been in charge of data handling of large sequencing projects but has also developed the PEDANT analysis pipeline for genome data. Berlin is a center of genomic data production and its bioinformatics project "Berlin Center for Genome Based Bioinformatics" (BCB) aims at developing and implementing the bioinformatics for bridging the gap from genome research to medicine. The central theme of the Jena Centre of Bioinformatics (JCB) is molecular medicine, in particular molecular communication processes in normal and pathological states of cells. The association of University of Halle with the plant biology research laboratory in Gatersleben is, of course, focussing on the development of bioinformatics tools for plant genomics. CUBIC, the "Cologne University Bioinformatics Center", concentrates on molecular networks in organisms. In particular, using the parallel analysis of experimental genome, transcriptome, proteome, structure, function and metabolome data, new tools for the simulation of biochemical functions with the goal to simulate whole cells will be developed. The bioinformatics competence center "Intergenomics" in Braunschweig has the scientific goal to develop bioinformatic tools for modeling of the interactivity of genome-driven bacterial infection processes in mammals and plants. The presence of several large research labs, a strong university and a large bioinformatics company (LION Bioscience) makes Heidelberg an important center, too. There, as well as in Hamburg and Dresden, also private donors are skipping in to promote bioinformatics. Freiburg, another center of both life science research and computer science, is also currently building up bioinformatics. In Leipzig, the Interdisciplinary Center for Bioinformatics (IZBI) focuses on the study of evolution, gene regulation, signalling pathways and tissue organization.

Of the many branches of bioinformatics, German researchers have particularly pursued structural biology and computational chemistry, biomolecular sequence analysis, database development for genome research and more recently the computational support for functional genomics. With the availability of whole-genome sequence and functional data, also the integration of bioinformatics and theoretical biology with the goal of a new systems biology is entering the focus of research. Late in 2001 the Ministry of Research has announced that it will support initiatives in systems biology. At the same time, ongoing projects in genome research and its medical application (the "National Genome Research Network", NGFN) rely on and integrate bioinformatics. Service provision to molecular biology laboratories is currently being pursued by the Helmholtz Network Bioinformatics (HNB, funded by the Ministry of Research). This association of bioinformatics groups is developing a platform for integration of a wide range of services and tools in order to make them easily available, in particular to the German biological research community. Taken together, not only research and development in bioinformatics are

growing in Germany, but also the acceptance of bioinformatics as a research tool has increased and is now widely recognized in the biomedical community.